



Figure 5.

Craterocephalus cuneiceps Whitley. Mount Curious district, Murehison River. Austr. Mus. regd. no. IB.3205.

—G. P. Whitley, del.

second line, "anal origin" should have read "dorsal origin" and the species has about 30 scales between head and hypural joint instead of 38 as printed. The species is here figured for the first time from the largest specimen in the Australian Museum, presented by Dr. D. L. Serventy. The following characters and variation are noteworthy:

D. vi/i, 7; A. i, 7; P. i, 11-13. Sc. 29-32. Tr. 9-10. Predorsal se. 10-14. Interdorsal 3-4. Head about 3.4 to 3.6, depth between 4 and 5 in standard length. Eye less than interorbital and than depth of caudal peduncle. Mouth not reaching eye. Mandibular rami gently elevated. One row of cheek-scales. About 8-10 short gill-rakers on lower part of first branchial arch. Vent between, or near, tips of adpressed ventral fins. Dorsal originating over ventral rays or over ventral-anal interspace, either nearer snout than tail-root or equidistant from those. No dark spots below lateral band which is below fourth seale-row.

Craterocephalus capreoli Rendahl, 1922, from Roebuck Bay, differs from *cuneiceps* in having A. i, 9; Tr. 7; height 19.2% of standard length (23 in *cuneiceps*); and ventrals well ahead of level of first dorsal origin.

OBSERVATIONS ON THE LITTLE SHEARWATER AT THE NEST

By JOHN WARHAM, Albany, W.A.

The most northerly breeding colonies of the Little Shearwater (*Puffinus assimilis*) known in Western Australia are on the Abrolhos Islands; south of these the birds breed near Jurien Bay, on Rott-nest Island, on Eelipse Island near Albany, and on the Archipelago of the Recherche (Serventy and Whittell, 1951). Alexander (1928) gives the world range as the Atlantic, Indian and Pacific Oceans and many sub-species have been described. The Western Australian race (*P. assimilis tuncnyi*) was named from skins collected in

1906 on Boxer Island, Recherche Archipelago. The taxonomic relationships of the Australian breeding populations have been discussed by Fleming and Serventy (1943).

The present paper is based on observations made during two visits to Eclipse Island lasting from July 9-24, 1954, and from September 9-24, 1954, by my wife and me. Eclipse Island lies about 4 miles from the coast and is almost due south of Albany. It is about $1\frac{1}{2}$ miles long by $\frac{1}{2}$ mile wide and rises to 357 feet at the highest point, on which the lighthouse has been built. The coastline is everywhere rocky; there are no beaches and parts of the northern side are very steep. To the south the ground falls away rapidly from below the lighthouse, beneath which there is a good accumulation of talus; the slope then flattens out somewhat to form a rather sandy area covered with grass and pigface. Casuarinas and coastal tea-tree (both reaching 40 feet in height) flourish wherever their roots can obtain a purchase and particularly along the sides of the storm-water gullies and on the northern slopes. Much of the surface of the island is covered with low shrubs and pigface, and there are also areas of bare rock mainly at the west end. The introduced arum lily is thriving and still spreading.

The behaviour of the Little Shearwater on Eclipse has been studied previously by a lighthouse-keeper once stationed there, Mr. A. V. Newman, and the results of his painstaking work have been made available through the publication of a paper by Mr. L. Glauert (1946). This appears to be the only material covering the nesting behaviour of the species in Australia.

WEATHER

Little Shearwaters nest at the height of the winter and egg-laying commences at the end of June (Glauert, 1946). During the first of our stays on Eclipse (July 9-24) wind and rain were our constant companions. From July 19-21 a full gale blew up with the wind swinging from N.W. to S.W. and accompanied by squally showers and heavy rain. Despite this, none of the incubating shearwaters under observation were found to be adversely affected. However, bad weather must have some effect on breeding success, and of 6 nests studied by Newman, two were abandoned on account of flooding. During the second visit the weather was much less inclement though further spells of wind and rain were encountered and rough seas delayed our departure.

GENERAL NOTES

Little Shearwaters nest in burrows either scraped out beneath the rocks or dug in the soil. Many pairs burrow among the talus on the south side below the lighthouse, some merely finding a convenient hollow under a boulder and laying their single egg without having to undertake any excavation at all. Probably the biggest concentration of nests is on a siding covered with pigface and lying approximately north-west of the cottages, but the colony below the lighthouse is the most convenient for study purposes. Some of the nesting chambers are only a few feet down, and by getting one's head close to the entrance the sitting birds may be seen with the

aid of a toreh. Others are quite inaccessible, the way to the chamber being by a devious tunnel which works around projecting rocks and stones. The nest itself is usually sparsely lined with grasses, dry pigfae stems, and the like.

When preparing to incubate the Little Shearwater adopts the contortions characteristic of its trihe at such times — it straddles the egg and pushes it into place with its beak, at the same time holding its drooping wings slightly away from its body. One bird in an unusually open site gave a momentary threat display when I moved a stone from the front and reached inside to feel the egg. The bird backed away, jabbed its beak at my hand, and raised its half-opened wings on either side of its body.

During our first stay all the nests inspected held eggs; on the subsequent visit most of them held chicks. Unfortunately the hatch was missed in all cases, and by the time of the return visit most of the young appeared to be 2 to 3 weeks old. At this stage the primaries were about $\frac{1}{2}$ inch out of the quills. The deep nestling down is grey on the back, light grey on the belly, and almost white on the throat. Eye brown; beak dark grey; knee, upper parts of legs and webs, grey-blue; sides of legs and toes dark grey. Many of the adult birds on Eelipse have a dark spot on their otherwise white cheeks. Glaucert gives 52-58 days as the incubation period and 70-75 days for fledging.

At night the incoming birds are often able to land within a few feet of their burrows, sometimes right at the entrance. Some crash into the bushes and subsequently work their way to their nests. Moonlight does not prevent the birds from coming in, and their white underparts show up for a moment as they flash by. High flying birds sweeping through the lighthouse beams look like meteors in a November sky. Sometimes it appears that the shearwater comes straight in from the sea and lands at its first approach, hut more often several circuits are made before the bird comes to earth. This is particularly true if one is standing near a burrow, and on moonlight nights an individual bird may be seen to fly on the same course several times, hesitating at the same place on each occasion and then continuing for another circuit but eventually alighting there. Little shearwaters come in at quite a high speed, then seem to flutter their wings at a small amplitude and finally stall and drop to the ground. Taking off seldom gives the birds much trouble; for practically all the nests are on sloping ground, and even on calm nights they can soon bounce their way into the air.

VOICE

During our visits Little Shearwaters were never noisy birds. Apparently we were too late to hear them in full cry; for Newman found that in early January, when they begin to return, the noise is deafening particularly on dark and stormy nights. Although we had many such nights, during our first period on the island we never heard a shearwater call while on the wing. This was not for want of listening; furthermore our sleeping quarters were within five yards of several occupied nests. During the second period a



Fig. 1.—Commencement of the feeding operation in *Puffinus assimilis*. The chick thrusts its beak against the parent's head and throat.



Fig. 2.—Food transference: the chick's bill is inside the adult's, at right angles to it and on top of the adult's tongue.

little calling was heard. Between September 10 and 12 the birds coming in were silent; it was moonlight. On September 17 a single bird called briefly as it flew overhead; this was on a clear starry night with little wind and the moon not yet visible. The following night was similar, but there was more calling from the sky than we ever heard before or afterwards. Some incoming birds even called when the moon came up. On the next two nights a little calling was heard; the wind was fresh and from the N.E. For the rest of our stay the flying birds were silent once more. Glauert suggests that the calling is used for "the asking and giving of direction, information most necessary on dark rainy nights when visibility is bad". That the birds were usually silent over the period of the present study apparently runs contrary to this view since at the time of the first visit the eggs were quite fresh yet the relieving birds had no difficulty in locating their nests in complete silence despite abominable weather. Later, when the chicks were being fed, there were no adults in the burrows to reply to those flying in from the sea; yet the latter were often able to pick out their nesting sites with such accuracy that they could alight within a few feet of them. Perhaps it is more likely, therefore, that vigorous calling both on the ground and in the air is associated with the early stages of the breeding cycle, with aerial chases (as is the case with *Pterodroma macroptera*) and courtship. By the time that incubation has begun the incoming birds know their way about without needing vocal clues to guide them. Possibly, too, non-breeding birds have by this time ceased to visit the island.

In describing the voice of the Madciran race of the Little Shearwater (*Puffinus assimilis baroli*), Lockley (1952) finds it just like a high-pitched version of the Manx Shearwater (*P. puffinus*). This is certainly not true of the Eclipse Island birds, which had voices quite different in timbre and rhythm from Manx Shearwaters of the West Wales Islands. All the *assimilis* calls heard by the present writer could be described as hoarse, asthmatical croonings based on the phrase: "wah, i-wah-i-wah-ooo" with the emphasis on the first syllable. This phrase is repeated two or three times and ends in an incoherent splutter. The "wah's" are apparently uttered as the breath is expelled, the rest of the call on the intake. This "song" is used both by flying birds and those on the ground. It is also the basis of the crooning duets that take place during the changeover at the nest. As is the case with Manx Shearwaters, Little Shearwaters will sometimes give voice in broad daylight as they sit in their burrows; it appears to be the vibration caused by observers' feet that triggers off their response (Warham, 1950). When handled some Little Shearwaters are silent, others struggle violently and growl like a dog. A sitting bird did this when I attempted to feel the egg beneath it. Adults sometimes make similar noises while feeding their young. Small chicks utter the usual liquid chirrup when soliciting food.

BEHAVIOUR IN THE NEST

In order to study the birds inside their nests a method formerly employed with the shearwaters of Skomer Island, West Wales



Fig. 3.—Little Shearwaters duetting outside their nest.



Fig. 4.—Nocturnal flight over the breeding ground; the bird is about to lower its legs in preparation for alighting.

(Warham, 1952) was adopted. Two sites were chosen where the nesting cavity was not far below the surface. The chick was taken out (the parents being absent by day), the floor of the chamber covered with a cloth and the roof carefully removed. The nesting cavity was then tidied up, the cloth taken away, the chick replaced, and the whole covered by a false roof of boards. Special care was taken to see that rainwater could not seep inside. On the following day hides were rigged up on top of the nesting chambers but well clear of the entrances, the configuration of which had not been altered during the excavations. At dusk the false roof could be removed and the behaviour of the occupants studied with the aid of a red light set some 3 feet from them. High-speed photography was found very useful, since the action of the birds are sometimes so rapid that it is difficult to see just what is happening even with the subjects at one's feet. One pair (nest A) was under observation in this way from September 11 - 23, the other (nest B) from September 13 - 23. During these periods at least one and often two adults were in attendance on the chick every night with the exception of September 16 for nest A (when no inspection was made) and September 22 for nest B when no adult had appeared by 10.30 p.m. This indicates rather more attentiveness than Glaucert gives in his paper ("normally the chick is fed every second night") though his figures are based on two inspections daily — at 9 a.m. and 9 p.m. Obviously, however, my observations are based on too small a sample for any generalisations in this respect.

The sequence of events on most nights was much the same. On my arrival the chick would generally be sleeping, but sometimes would be awake, preening and stretching its wings. As I found with *P. puffinus*, the young one also reaches out and collects any small grasses, feathers, and the like, and tucks these in around it. The parent bird would arrive between 7.05 and 7.40 p.m., and on quiet nights the "plop" of an alighting bird might be heard a short while before. The nestling begins to chatter excitedly as the parent enters the nest, and feeding begins immediately to last for 15 to 20 minutes. Feeding takes place in four stages:

1. The chick cheeps continually and drives its beak in the general direction of the old bird's head (Fig. 1). The adult may preen the chick's head during this stage.
2. Parent and chick fence with their beaks, chick still calling vigorously.
3. Beaks interlock and remain crossed as food is transferred. Chick is silent but usually beats its wings. Beaks remain in contact for about 5 seconds. The old bird's bill is opened wide and that of the chick generally crosses it more or less at right angles as shown in Fig. 2.
4. Chick withdraws bill, swallows, and is silent. A slight pause and the cycle is repeated.

During these operations the old bird is usually silent, but it sometimes growls during stages 1 or 2, and on one occasion a parent burst into "song" between feeds. This behaviour corresponds closely

with my own observations of the Manx Shearwater, and Rowan's (1952) description of the feeding of the chick of the Greater Shearwater (*P. gravis*) on Tristan da Cunha show that in this species, too, similar arrangements hold good. Feeding was never seen later in the evening but only immediately after the adult's arrival. Following this the chick usually went to sleep, and the parent if unaccompanied by its mate often did the same. One chick appeared to sneeze a number of times before settling down, and yawns often precede sleep! The adult may tuck its head into the shoulders when resting or may merely remain motionless in the chamber or the tunnel with its head on its breast. A tour of occupied sites around 10.30 p.m. would reveal most adults resting or sleeping in this way and they may be there even in the early hours of the morning. It appears that a long rest follows each visit and the parents leave the island some time before first light.

At nest A one of the adults often sat outside the burrow after feeding, and on one occasion this bird appeared to pick small pieces off a spray of tea-tree and to throw them over its shoulder; but observation was difficult and may have been faulty.

Glauert mentions that the *assimilis* chick defecates into the end of the nesting chamber; this was often noted during the present study, and the same is true of *P. puffinus*. On the other hand Rowan records that in *P. gravis* the chick uses the entrance tunnel as a midden.

When both parents appeared at the nest only one was ever seen to feed the chick on any night. The unemployed bird would generally sit outside or squat in the tunnel, and when feeding was over both would preen themselves and the heads and bodies of each other. There was a good deal of crooning at such times, the birds making a duet of the "wah, i-wah-i-wah-ooo" call, uttering it with slightly down-turned bills. The throat swells during this performance and the nape is arched as can be seen from Fig. 3

The peculiar manner in which the young shearwater drives its beak at the head of the parent before their bills make contact is doubtless an adaptation to the darkness that normally prevails in the inside of the cavity. The birds have, therefore, to rely on their sense of touch and possibly of smell. In some species at least the parents can be very clumsy in their movements within the nest and tread on the chick when they attempt to brood it.

When watching shearwaters, especially at or before the egg-stage, one is tempted to suspect that sense of smell may be used in guiding incoming birds to their mates. Burrows and occupiers have an odour that varies from one species to the next, and it is well known that the nasal glands are unusually large in shearwaters and in some petrels and albatrosses. Technau (1936) gives some diagrams and the subject has been discussed more recently by Mangold (1946), but no proof of the birds' possession of a sense of smell seems available.

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BIRD-LIFE AT WOOROLOO: Part I

ERIC H. SEDGWICK, Williams.

The Wooroloo district, situated in the Darling Range, 28 miles E.N.E. of Perth, is in the heart of the jarrah forest belt.

In its primeval state it was entirely forested, mainly with jarrah (*Eucalyptus marginata*) and marri (*E. calophylla*) on the laterite soils and with marri and wandoo (*E. redunca*) in other areas. A number of watercourses drain the district and these support flooded gum (*E. rudis*) and blaekbutt (*E. patens*). *Xanthorrhoea* spp. are abundant and *Macrozamia* occurs.

A good deal of timber-getting has taken place, but comparatively little of the country has been entirely cleared. The cleared areas are mainly in valleys, though, generally speaking, a narrow belt of natural vegetation has been preserved along the watercourses. The cleared areas have been developed either as pear, peach, and plum orchards, or as pasture.

It is no easy matter to divide this district into habitat areas, but the following division has been adopted:

- Jarrah Forest.
- Wandoo Forest.
- Watercourses.
- Orchards.
- Pasture land.